MARLAP Measurement Uncertainty Workshop

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The *Multi-Agency Radiological Analytical Protocols Manual* (MARLAP), which was approved and released in 2004, recommends a performance-based approach to planning and implementation of projects that involve radiochemical analysis. Measurement uncertainty plays a crucial role in much of the manual's guidance. In particular, MARLAP's approach to method selection in Part I is based on the planning team's uncertainty requirements for decision-making, and criteria for evaluating the continuing performance of the laboratory are based on the "required method uncertainty," a concept introduced by MARLAP. For these reasons, Part II of MARLAP, which is aimed at laboratory personnel, emphasizes the need for good uncertainty evaluations. MARLAP recommends that labs follow the *Guide to the Expression of Uncertainty in Measurement* (the "GUM") to ensure consistency and comparability of uncertainty statements.

This workshop provides an introduction to the role of measurement uncertainty in the MARLAP guidance and demonstrates methods and tools that can be used to make uncertainty evaluations in the laboratory easier. Specific topics of the workshop include:

- an overview of the role of uncertainty in MARLAP
- a brief refresher on the GUM
- the definition of the "required method uncertainty" and its role in selecting a method and evaluating a lab's continuing performance
- the use of software tools for propagating uncertainty automatically, including the Kragten spreadsheet (*Analyst*, **119**, 1994, 2161—2165), software component libraries, and standalone applications

The Kragten Spreadsheet: An Easier Way to Estimate Uncertainty

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A spreadsheet tool based on the Kragten spreadsheet (*Analyst*, **119**, 1994, 2161-2165), that simplifies the calculation of the combined standard uncertainty, u_c, is described. No calculus is required. Given a measurement equation and mean values, standard uncertainties, and degrees of freedom for each input, this spreadsheet automatically calculates the combined standard uncertainty, effective degrees of freedom, coverage factor, and expanded uncertainty. In addition, the spreadsheet computes additional quantities, such as sensitivity coefficients and relative contributions of each uncertainty component to the combined standard uncertainty, which can give insight into the measurement process and can be used for optimization. The concept of the Kragten spreadsheet, as well as its advantages and disadvantages, compared to using calculus or relative uncertainties, are explained. The utility of the spreadsheet and steps to ensure the validity of its results are demonstrated with examples.